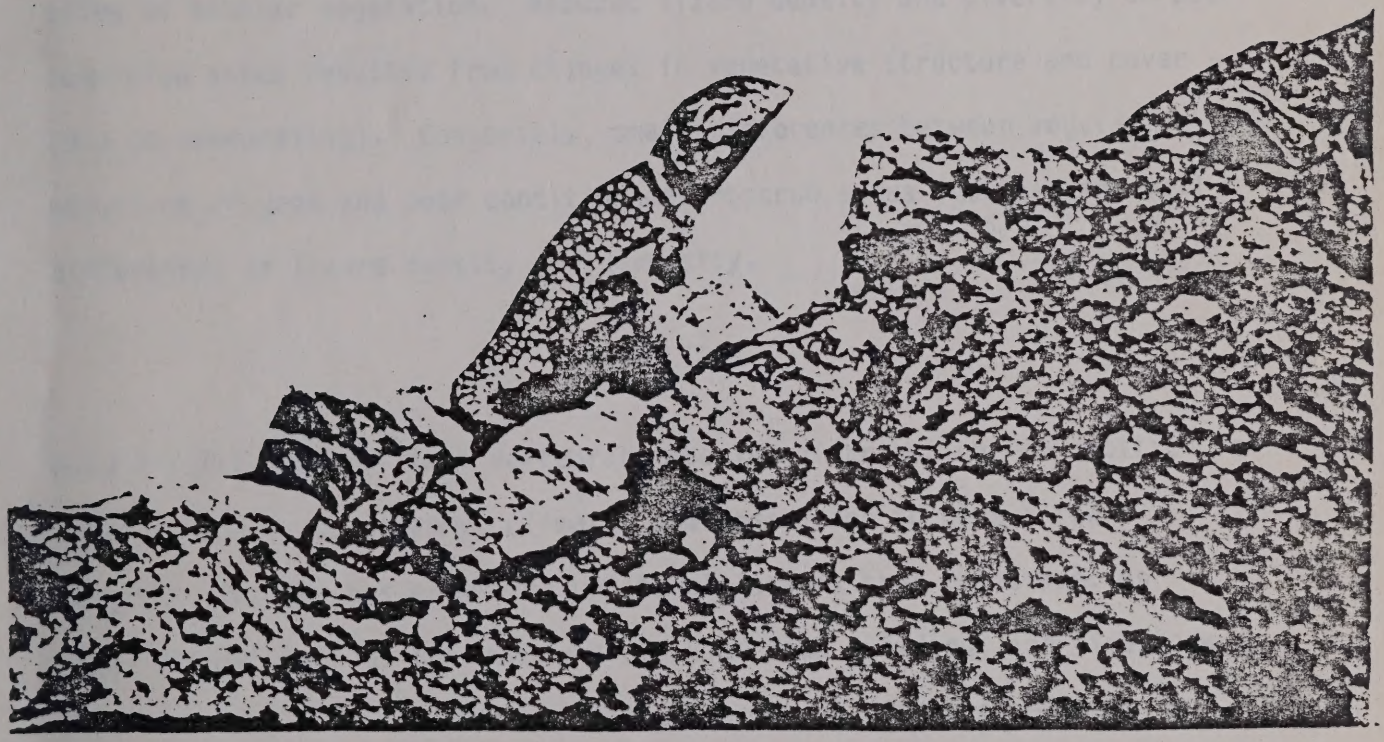
Effects of Overgrazing on the Lizards of Five Upper and Lower Sonoran Habitat Types



by

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A paper submitted to the Western Section

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ABSTRACT

Lizard populations sampled on poor condition (heavily grazed) chaparral, desert grassland, mixed shrub dry wash, and mixed broadleaf riparian sites demonstrated lower density and diversity than on identical sites under good condition (nongrazed). Poor condition desertscrub showed only slight differences in lizard density and diversity when compared to good condition sites of similar vegetation. Reduced lizard density and diversity on poor condition sites resulted from changes in vegetative structure and cover (due to overgrazing). Conversely, small differences between vegetative structure of good and poor condition desertscrub sites resulted in small differences in lizard density and diversity.

INTRODUCTION

Many natural factors limit vertebrate species distribution--competition for food and space, topography, climate, and vegetation to name a few. Recently, concern has grown for unnatural factors that limit species distribution, such as off-road vehicle use, road building, and livestock grazing. Only a few studies, however, have dealt with such effects on reptiles.

Berry (1978) discussed the effects of grazing on physical and socioecological parameters as they relate to the desert tortoise, Gopherus agassizi. She suggested that trampling of tortoises and their burrows,

forage competition, and habitat degradation (all caused by livestock) are responsible for observed increases in mortality, decreases in individual growth rates, and decreases in clutch size.

Busack and Bury (1974) found an inverse relationship between sheep grazing and lizard populations: an ungrazed study plot had twice the number of lizards and three times the biomass of a grazed plot. They related the greater biomass on the grazed plot to the loss of cover, loss of social structure, invertebrate fauna degradation, and direct casualties.

Although Berry (1978) and Busack and Bury (1974) have related grazing-caused vegetative degradation to a decline in tortoise and lizard populations, neither has discussed reptilian decline caused by vegetative structural changes.

Pianka (1966) demonstrated a correlation between the number of lizard species and several different structural attributes of vegetation. In most cases he found that habitats with increased plant structures (expressed as plant species diversity and plant volume density) support more lizard species than those with fewer plant structures. He correlated this finding to increases in both structure of the habitat and foraging. On the basis of species-specific structure and foraging requirements, he assigned life-form designations for each lizard (Table 1).

Similar studies on birds have demonstrated a relationship between avian

Table 1 Summary of Life forms for Lizard Species of the Black Canyon-Skull Valley Planning Areas

I Widely foraging species. . . . .whiptail lizards (Cnemidophorus)

II Sit-and-wait species

(a) Under bushes and on large rocks, litter, etc. . .side-blotched lizards (Uta), collared lizards (Crotaphytus)

(b) Open spaces between shrubs. . . . .horned lizards (Phrynosoma), zebra-tail lizards (Callisaurus), greater earless lizards (Cophosaurus), lesser earless lizards (Holbrookia), leopard lizards (Gambellia)

(c) Arboreal (trees, large bushes). . tree lizards (Urosaurus), desert spiny lizards (Sceloporus)

III Herbivorous

(a) (IIa-d) desert iguana (Dipsosaurus)
(b) (IIa) chuckwalla (Sauromalus)

Nocturnal Species

I Open foraging banded gecko (Coleonyx)

II Olfaction and digging gila monster (Heloderma)

species and structural attributes of the environment (Balda 1969; Johnson 1973; McArthur 1964; Anderson and Ohmart 1976).

The effects of livestock grazing on vegetation have been well documented. Studies by Ellison (1960), Laycock (1967), Potter and Krenetsky (1967), Brown and Schuster (1969), Turner (1971), and Blydenstein et. al. (1957) indicate that heavy livestock use reduces biomass and diversity of annual forbs and grasses and changes the composition of shrub species.

The relationship between lizard species and structural aspects of each habitat and the documented effect of overgrazing on vegetation should be reflected in lizards on heavily grazed and nongrazed sites demonstrating differences in density and diversity. The effect of grazing on individual species should also vary, depending on life-form requirements for each species.

Concern of various interest groups over non-natural factors affecting vertebrates has led to legislation dictating the identifying of factors and their effect on wildlife. From this mandate the Bureau of Land Management (BLM) Phoenix District inventoried lizard populations in the Black Canyon and Skull Valley planning areas to obtain data for determining the effects of grazing on these populations.

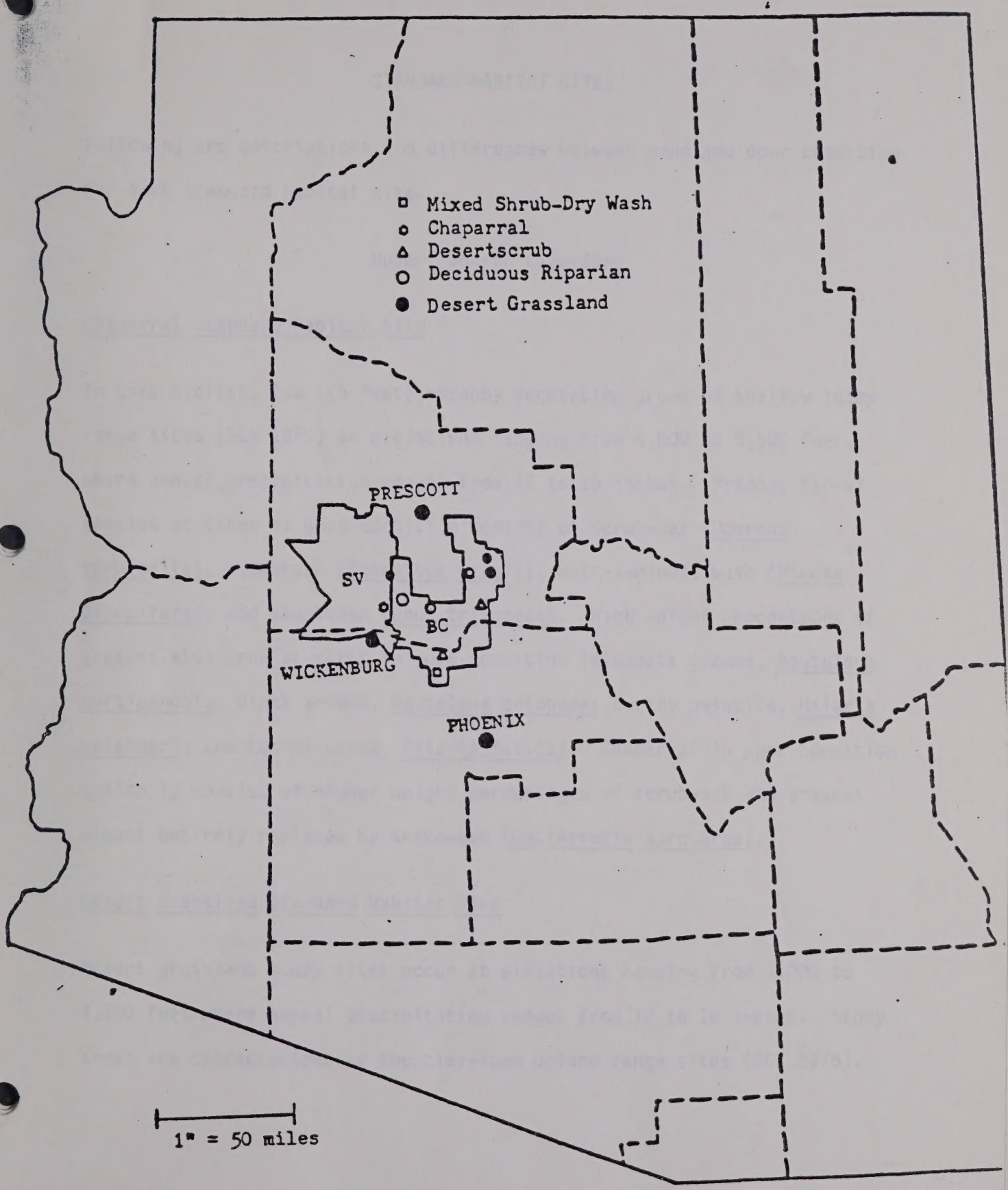
ACKNOWLEDGEMENTS

I express my deepest appreciation to Robert Furlow and the Bureau of Land Management for allowing me to undertake this study. I am also grateful to Dr. Ted T. Allen who aided in obtaining field data on lizard populations. Special thanks also go to Ted Cordery who was most helpful in interpreting field data and how it relates to range condition. Finally, I sincerely acknowledge Ken McGinty for editing this manuscript.

DESCRIPTION OF THE STUDY AREA

Located north of Phoenix in Maricopa and Yavapai Counties, Arizona (Figure 1), the Black Canyon and Skull Valley planning areas include both upper and lower Sonoran life zones (Brown and Lowe 1974). Within these planning areas five standard habitat sites were established (BLM 1977). Fourteen study areas were established in each of the standard habitat sites, seven in good condition and seven in poor condition. Condition was determined by the Soil Conservation Service (SCS 1976) range site method. The condition of poor sites resulted almost entirely from overgrazing, as indicated by present and past use and the lack of other factors, such as ORV trails, floods and burnoffs. The condition of good sites, on the other hand, resulted from their inaccessibility to livestock and their lack of wild burros.

Figure 1. Study Areas of the Black Canyon-Skull Valley Planning Units



STANDARD HABITAT SITES

Following are descriptions and differences between good and poor condition for each standard habitat site.

Upper Sonoran Life-Zone

Chaparral Standard Habitat Site

In this habitat, low (<5 feet) shrubby vegetation grows on shallow loamy range sites (SCS 1976) at elevations ranging from 4,000 to 5,500 feet, where annual precipitation ranges from 12 to 16 inches. Primary floral species at sites in good condition consist of scrub-oak (Quercus turbinella), buckbrush (Ceanothus gregii), wait-a-minute bush (Mimosa binucifera), and skunkbush (Rhus trilobata). High weight percentages of grasses also grow at sites in good condition (sideoats gramma, Bouteloua curtipendula; black gramma, Bouteloua eriopoda; curley mesquite, Hilaria belangeri; and tobosa grass, Hilaria mutica). Chaparral in poor condition typically consist of higher weight percentages of scrub-oak and grasses almost entirely replaced by snakeweed (Gutierrezia sarothrae).

Desert Grassland Standard Habitat Site

Desert grassland study sites occur at elevations ranging from 4,000 to 4,500 feet where annual precipitation ranges from 12 to 16 inches. Study areas are characterized by the clay-loam upland range sites (SCS 1976).

Good condition study sites consist of high weight percentages of tobosa grass and curley mesquite. Poor condition study sites have high percentages of mesquite (Prosopis glandulosa), catclaw (Acacia gregeii), and snakeweed and only a trace of perennial grasses.

Lower Sonoran Life-Zone

Desertscrub Standard Habitat Site

Desertscrub study sites were established on volcanic hills range sites (SCS 1976) where annual precipitation ranges between 7 and 10 inches and elevation ranges from 1,200 to 2,300 feet. Vegetation at good condition sites included paloverde (Cercidium microphyllum), saguaro (Cereus giganteus), brittlebush (Encelia farnosa), and flat-top buckwheat (Eriogonum fasciculata). Perennial grasses (tobosa grass and big galleta, Hilaria rigida) and forbs (desert trumpet, Eriogonum inflatum) also make up a high percentage of the weight composition. Poor condition sites consist of shrubs similar to those of good condition sites but almost entirely lack perennial grasses and forbs.

Deciduous Woodland Riparian Standard Habitat Sites

Riparian standard habitat sites are associated with perennial and intermittent flood plains that bisect both upper and lower Sonoran life-zones. Riparian deciduous woodland was divided into two

subdivisions--mixed shrub-dry wash standard habitat sites occur at low desert elevations with no surface water and mixed broadleaf riparian standard habitat sites occur at higher elevations having surface water or a high water table.

Mixed Shrub-Dry Wash Standard Habitat Sites

Mixed shrub-dry wash habitat sites occur on the sand bottom range site (SCS 1976), where elevation ranges from 1,200 to 1,830 feet and annual precipitation ranges 7 to 10 inches. Good condition sites consist of ironwood (Olneya tesota), blue paloverde (Cerdium floridum), wolfberry (Lycium sp.), and canyon ragweed (Ambrosia ambrosioides). Perennial grass (bush muhly Muhlenbergia porteri and big galetta), forbs, and annual grass also constitute a relatively high percentage of the total vegetation. Poor condition sites have a similar shrub composition but lack perennial and annual grasses.

Mixed Broadleaf Riparian Standard Habitat Site

Mixed broadleaf communities also occur on the sandy bottom range site (SCS 1976) at elevations from 3,500 to 4,500 feet where annual precipitation ranges from 12 to 16 inches. In this study, mixed broadleaf riparian occur in flood plains transecting only upper Sonoran life-zones. Good condition sites are characterized by both young and old cottonwood (Populus fremonti), willow (Salix sp.), sycamore (Plantanus wrightii), Arizona

walnut (Juglans major), velvet ash (Franxinux pennsylvanica), and oak (Quercus emoryi and Quercus arizonica). Arizona grape (Vitis arizonica) also occur in high weight percentages at good condition sites. Perennial grass (Dropseeds, Sporobolus sp., sideoats, and squirreltail, Sitanion sp.), forbs and annual grasses make up relatively high percentages of the total weight composition. Poor condition study sites consist of only adult trees of the previously mentioned species and almost no perennial grasses, forbs, or annual grasses.

METHODS

Lizard density per hectare and lizard diversity (total number of species) was determined at each of the 14 study sites and for each standard habitat site between March and June, 1978. Lizard density was determined by making a transect of two parallel lines, 50 feet apart. Two biologists walked simultaneously along the lines counting the distance until a lizard was sighted. When a lizard was sighted two distances were measured. The first distance measured was the length of the transect to the perpendicular point at which the lizard was first spotted. The second distance recorded was the perpendicular length from the transect to the original location of the lizard. Lizards were recorded by species code with their ages (adult or juvenile) and sexes (male or female where applicable).

The biologists continued to walk the parallel lines recording lizards as

previously described. The length of the lines varied but were usually 1 mile, depending on topography. The sampling area was determined by multiplying the length of the parallel lines by the greatest distance laterally between lizard sightings.

Densities were determined for each species sighted as well as adult to juvenile and sex ratios for each condition class of each standard habitat site.

An array trapping scheme was used (modification of method by Campbell and Christman 1977) at study sites to obtain voucher specimens. The array trapping method involved placing four 5-gallon containers into the ground, their tops flush with the surface. Drift fences (16 inches tall) were then erected between buckets and supported by stakes.

Vegetation structure (vertical aspect) of the 14 study sites was determined for each standard habitat site by a toe-point transect in which (where topography permitted) straight lines were walked recording canopy hits. A minimum of 300 30-foot stations were obtained to assure relatively large numbers of canopy hits.

Canopy hits at each station were subdivided into five structural height classes: Class 1 (<1'), Class 2 (1-2'), Class 3 (2-4'), Class 4 (4-15'), Class 5 (>15'). The total number of canopy hits for each height class was expressed as a percentage of the total number of canopy hits. Percent

cover for each of the 14 sites was expressed as the number of canopy hits versus the total number of stations established per transect. Hits of rock, debris, and litter were expressed as a percentage of the total number of stations.

Means and standard deviations of lizard density and vegetation structure were computed for each standard habitat site but not tested for significance between poor and good condition sites.

RESULTS

This study obtained relative densities of 23 species of lizards for five standard habitat sites. The number of species found varied between standard habitat sites and condition classes of each (Table 2). Chaparral habitat had the largest number of lizard species (14) and showed no difference between good and poor condition study sites (Table 2). Desertscrub and mixed shrub-dry wash standard habitat sites consisted of 13 species on both poor and good condition study sites (Table 2). Mixed broadleaf riparian standard habitat sites in poor condition had 10 resident species, whereas good condition sites were represented by 13 resident species (Table 2). Grassland standard habitat sites had the largest difference of resident lizard species (9 in poor condition and 14 in good condition) (Table 2).

Mean relative lizard density per hectare was highest on good condition,

Table 3. Lizard densities and adult to juvenile and sex ratios on poor and good condition standard habitat sites. Density is the number of lizards per hectare (ha.) ± one standard deviation. N= the total number of lizards of a given species sampled. Sex ratios are expressed as males:females.

	CHAPARRAL								DESERT GRASSLAND								DESERTSCRUB							
	Poor (grazed)				Good (non grazed)				Poor (grazed)				Good (non grazed)				Poor (grazed)				Good (non grazed)			
Species	(n)	Sex Ratio	Ad.-Juv.	Den.(L/ha.)	(n)	Sex Ratio	Ad.-Juv.	Den.(L/ha.)	(n)	Sex Ratio	Ad.-Juv.	Den.(L/ha.)	(n)	Sex Ratio	Ad.-Juv.	Den.(L/ha.)	(n)	Sex Ratio	Ad.-Juv.	Den.(L/ha.)	(n)	Sex Ratio	Ad.-Juv.	Den.(L/ha.)
Side-blotched lizard (Uta stansburiana)	5	3:1	1:2	0.3±0.1	21	11:10	13:8	2.5±0.4	22	13:9	12:10	1.6±0.3	12	6:6	5:7	1.5±0.1	33	11:12	17:16	2.3±0.2	26	11:17	18:10	3.4±0.5
Tree lizard (Urosaurus ornatus)	17	8:9	6:11	3.0±0.3	19	12:7	12:7	2.2±0.5	18	7:11	5:13	1.3±0.4	2	2:0	2:0	0.7±0.1	21	11:10	9:12	1.5±0.3	14	11:3	5:9	1.2±0.4
Desert spiny lizard (Sceloporus magister)	27	13:14	20:7	3.1±0.7	37	20:17	26:11	4.3±0.3	30	12:18	17:13	2.2±0.6	13	6:7	8:5	1.9±0.3	98	53:45	61:37	6.9±0.7	83	51:32	44:39	7.2±0.9
Southern plateau lizard (Sceloporus undulatus)	36	48:11	54:5	6.9±1.0	46	30:16	23:23	5.5±0.2	--	-----	-----	-------	3	2:1	2:1	1.2±0.1	--	-----	-----	-------	--	-----	-----	-------
Long-tailed brush lizard (Urosaurus graciosus)	--	---:--	----	-------	--	-----	-----	-------	--	-----	-----	-------	-	---	-----	-------	--	-----	-----	-------	--	-----	-----	-------
Collared lizard (Crotaphytus collaris)	26	11:15	17:9	3.0±0.3	22	8:14	8:14	2.7±0.7	12	7:5	10:2	0.9±0.1	20	8:12	7:13	2.2±0.4	42	13:29	21:21	3.0±0.4	22	13:9	11:11	1.9±0.3
California whiptail lizard (Cnemidophorus tigris)	39	34:5	36:3	3.4±0.3	33	14:19	11:12	4.0±0.4	5	5:0	5:0	0.4±0.1	16	8:8	9:7	2.3±0.3	32	23:9	20:12	2.3±0.3	41	29:12	17:24	3.6±0.4
Plateau whiptail lizard (Cnemidophorus velox)	13	0:13	13:0	1.5±0.1	27	0:27	13:14	3.5±0.6	--	-----	-----	-------	5	0:5	2:3	0.9±0.1	--	-----	-----	-------	--	-----	-----	-------
Chihuahuan whiptail lizard (Cnemidophorus exanguis)	38	0:38	27:1	3.3±0.7	41	0:38	19:22	4.9±0.4	--	-----	-----	-------	5	0:5	2:3	0.9±0.1	--	-----	-----	-------	--	-----	-----	-------
Gilbert's skink (Eumeces gilberti)	3	2:1	3:0	0.3±0.1	9	5:4	6:3	1.1±0.3	--	-----	-----	-------	--	----	-----	-------	--	-----	-----	-------	--	-----	-----	-------
Leopard lizard (Gambelia wislizenii)	7	6:1	7:0	0.8±0.1	12	3:9	6:6	1.4±0.3	--	-----	-----	-------	5	2:3	1:4	0.6±0.3	11	6:5	7:4	0.8±0.1	5	3:2	3:2	0.4±0.0
Greater earless lizard (Cophosaurus texana)	19	18:1	16:3	2.2±0.4	78	36:42	22:56	9.4±0.8	6	6:0	6:0	0.4±0.1	32	15:17	14:18	0.7±0.1	77	66:11	63:14	5.5±0.6	69	32:37	39:30	6.0±0.5
Lesser earless lizard (Holbrookia maculata)	9	8:1	8:1	1.0±0.0	21	11:10	13:8	2.5±0.3	--	-----	-----	-------	18	8:10	5:13	1.8±0.4	--	-----	-----	-------	--	-----	-----	-------
Zebra-tailed lizard (Callisaurus draconoides)	26	23:3	21:5	3.0±0.3	83	39:44	31:52	10.0±1.2	4	3:1	4:0	0.3±0.1	12	7:5	5:7	3.3±0.0	29	20:9	15:14	2.1±0.5	34	26:8	21:13	3.0±0.3
Short-horned horned lizard (Phrynosoma douglassi)	4	2:2	3:1	0.5±0.1	3	2:1	1:2	0.4±0.1	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------
Regal horned lizard (Phrynosoma solare)	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------	17	6:11	11:6	1.2±0.3	17	7:10	13:4	1.5±0.1
Desert horned lizard (Phrynosoma platyrhinos)	--	-----	-----	-------	--	-----	-----	-------	3	3:0	3:0	0.2±0.1	12	6:6	4:8	2.1±0.4	13	10:3	3:8	0.9±0.2	9	6:3	8:1	0.8±0.0
Chuckwalla (Sauromalus obesus)	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------	6	3:3	3:4	0.4±0.1	8	3:5	4:4	0.7±0.1
Desert iguana (Dipsosaurus dorsalis)	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------	2	1:1	1:1	0.9±0.6	8	7:1	8:0	0.6±0.1	4	4:0	4:0	0.3±0.1
Banded gecko (Coleonyx variegatus)	--	-----	-----	-------	--	-----	-----	-------	3	3:0	3:0	0.2±0.0	--	-----	-----	-------	3	2:1	3:0	0.2±0.0	1	1:0	1:0	0.1±0.0
	269	165:53	222:47	31.3±0.7	452	191:193	204:248	53.0±1.1	103	59:44	65:38	7.7±0.3	167	71:86	77:90	20.9±0.5	390	231:159	242:148	27.6±0.4	335	200:135	188:147	29.5±0.6
					14 species				9 species				14 species				13 species				13 species			

Table 3. (Cont.)

	MIXED SHRUB-DRY WASH								MIXED BROADLEAF RIPARIAN							
	Poor (grazed)				Good (non-grazed)				Poor (grazed)				Good (see grazed)			
	(n)	Sex Ratio	Ad.-Juv.	Den.(L/ha.)	(n)	Sex Ratio	Ad.-Juv.	Den.(L/ha.)	(n)	Sex Ratio	Ad.-Juv.	Den.(L/ha.)	(n)	Sex Ratio	Ad.-Juv.	Den.(L/ha.)
Side-blotched lizard (Uta stansburniana)	56	31:25	19:37	4.0±0.2	66	23:43	19:47	7.9±0.3	49	21:28	19:30	5.3±0.7	27	14:13	8:19	3.2±0.4
Tree lizard (Urosaurus ornatus)	101	33:68	29:72	7.2±0.8	39	19:20	14:25	4.6±0.5	68	20:48	17:51	7.3±0.4	33	17:16	11:22	4.0±0.3
Desert spiny lizard (Sceloporus magister)	84	47:37	31:53	6.0±0.5	46	16:30	18:28	5.3±0.6	78	19:59	18:60	8.4±0.4	42	23:19	27:15	5.1±0.5
Southern plateau lizard (Sceloporus undulatus)	--	-----	-----	-------	--	-----	-----	-------	23	11:12	14:9	2.5±0.2	13	10:3	5:8	1.5±0.2
Long-tailed brush lizard (Urosaurus gracioeus)	29	14:15	14:15	2.1±0.4	18	8:10	6:12	2.1±0.3	--	-----	-----	-------	--	-----	-----	-------
Collared lizard (Crotaphytus collaris)	2	2:0	2:0	0.1±0.2	10	6:4	5:5	1.2±0.3	23	16:7	21:2	2.5±0.2	13	8:5	6:7	1.6±0.4
California whiptail lizard (Cnemidophorus tigris)	23	30:3	22:1	1.6±0.5	57	34:23	26:31	5.6±0.8	34	29:5	30:4	3.7±0.2	57	23:34	18:39	6.9±0.5
Plateau whiptail lizard (Cnemidophorus velox)	--	-----	-----	-------	--	-----	-----	-------	8	0:8	8:0	0.4±0.1	14	0:14	3:11	1.7±0.3
Chihuahuan whiptail lizard (Cnemidophorus exanguis)	--	-----	-----	-------	--	-----	-----	-------	11	0:11	10:1	1.2±0.1	21	0:21	8:13	2.5±0.4
Gilbert's skink (Eumeces gilberti)	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------	4	2:2	2:2	0.5±0.0
Leopard lizard (Gambelia wislizenii)	2	2:0	2:0	0.1±0.1	16	10:6	6:10	1.9±0.2	3	3:0	3:0	0.3±0.1	7	3:4	5:2	0.8±0.1
Greater earless lizard (Cophosaurus texana)	15	13:2	14:1	1.1±0.3	89	40:49	27:62	10.6±0.4	18	15:3	17:1	1.9±0.5	80	31:49	26:54	9.6±1.3
Lesser earless lizard (Holbrookia maculata)	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------	7	4:3	3:5	0.8±0.0
Zebra-tailed lizard (Callisaurus draconoides)	12	11:1	12:0	0.9±0.3	68	31:37	21:47	8.1±0.7	44	21:23	17:27	4.7±0.7	76	33:43	40:36	9.2±0.9
Short-horned horned lizard (Phrynosoma douglassi)	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------
Regal horned lizard (Phrynosoma solare)	1	1:0	1:0	0.1±0.1	4	3:1	3:1	0.5±0.3	--	-----	-----	-------	--	-----	-----	-------
Desert horned lizard (Phrynosoma platyrhinos)	2	2:0	2:0	0.1±0.0	8	6:2	4:4	1.0±0.3	--	-----	-----	-------	--	-----	-----	-------
Chuckwalla (Sauromalus obesus)	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------	--	-----	-----	-------
Desert iguana (Dipsosaurus dorsalis)	2	2:0	2:0	0.1±0.1	13	7:6	6:7	1.5±0.2	--	-----	-----	-------	5	3:3	4:1	0.6±0.1
Banded gecko (Coleonyx variegatus)	1	1:0	1:0	0.1±0.0	2	2:0	1:1	0.2±0.3	--	-----	-----	-------	--	-----	-----	-------
	330	179:151	151:179	23.4±0.5	436	205:231	156:280	50.7±0.6	350	155:185	174:185	38.2±0.4	399	170:194	169:234	48.0±0.5
			13 species				13 species				10 species				13 species	

chaparral study sites (53.0) with considerably lower densities occurring on poor condition study sites (31.3) (Table 2). Large differences between these study sites resulted from large differences in densities of greater earless lizards (Cophosaurus texana), zebra-tail lizards (Callisaurus draconoides), and whiptail lizards (Cnemidophorus sp.) (Table 2). Adult to juvenile ratios and sex ratios were greater on poor condition chaparral sites than on sites under good condition (Table 2).

Mixed shrub-dry wash standard habitat sites had twice the mean lizard density on good condition sites than as on poor condition sites, 50.7 versus 23.4 (Table 2). The great difference in densities was largely due to differences in densities of the greater earless lizard, the zebra-tail lizard and the California whiptail lizard (Cnemidophorus tigris) (Table 2). Only the tree lizard (Urosaurus ornatus) and the desert spiny lizard (Sceloporus magister) demonstrated greater density at poor condition study sites (Table 2). As at chaparral study sites, mixed shrub-dry wash sites under poor condition had greater adult to juvenile and sex ratios than sites under good condition (Table 2).

Good condition mixed broadleaf riparian standard habitat sites had slightly higher mean lizard densities than heavily grazed poor condition sites, 48.0 versus 38.2 (Table 2). Good condition sites had higher densities of whiptail lizards, zebra-tail lizards and leopard lizards (Table 2). Moreover, three lizard species--desert iguanas (Dipsosaurus dorsalis),

lesser earless lizards (Holbrookia maculata), and Gilbert's skinks (Eumeces gilberti)--were verified at good condition sites but not at poor condition sites (Table 2).

On the other hand, poor condition sites had higher mean densities of desert spiny lizards, side-blotched lizards (Uta stansburniana), southern plateau lizards (Sceloporus undulatus), and collared lizards (Crotaphytus collaris) (Table 2). Total adult to juvenile and sex ratios at the mixed broadleaf riparian habitat sites were similar at good and poor condition sites but differed between individual species (Table 2). Side-blotched lizards, tree lizards, and desert spiny lizards demonstrated higher adult to juvenile and sex ratios at good condition sites (Table 2). The other lizard species demonstrated greater adult to juvenile and sex ratios at poor condition sites (Table 2).

Poor and good condition desertscrub standard habitat sites had similar mean lizard densities and showed little difference between individual species (Table 2). Adult to juvenile and sex ratios were also similar at both poor and good condition study sites (Table 2).

Desert grassland standard habitat sites demonstrated the largest differences between mean lizard densities of good and poor condition study sites, 20.9 versus 7.7 (Table 2). All species with the exception of the desert spiny lizard, tree lizards, and side-blotched lizards demonstrated

greater densities at good condition study sites (Table 2). Six lizard species--plateau whiptail lizards (Cnemidophorus velox), Chihuahuan whiptail lizards (Cnemidophorus exanguis), desert iguanas, leopard lizards, southern plateau lizards, and lesser earless lizards--were found residing at good condition grassland sites but did not occur at similar habitat in poor condition (Table 2). The banded gecko (Coleonyx variegatus) was the only species found at poor condition study sites not verified at good condition sites (Table 2). Adult to juvenile and sex ratios were greater at poor condition sites than at good sites (Table 2).

The structure of ungrazed and heavily grazed areas differed greatly on the chaparral, desert grassland, mixed shrub dry wash, and mixed broadleaf riparian standard habitat sites (Table 3). Mixed broadleaf riparian had the largest difference in structural composition with 42.9 percent of the vegetation at heights of less than 2 feet for good condition sites and only 4.7 percent of the vegetation at heights less than 2 feet at poor condition sites (Table 3). The differences between condition classes for the previously mentioned habitat types result from higher percentages of grasses, forbs, and young trees and shrubs at good condition sites and typically little or none of these low height vegetative types (due to heavy livestock grazing) at poor condition sites.

Desertscrub standard habitat sites demonstrated little structural difference between the two condition classes (Table 3), a result of low

Table 3. Summary of vegetation structure by height class for five standard habitat sites. The percentages of the total vegetative composition ± one standard deviation is listed for each height class. Total vegetative cover is also listed ± one standard deviation. N=14 for each condition class.

Standard Habitat Site	Class 1	Class 2	Class 3	Class 4	Class 5	Percent Cover
Chaparral						
Poor condition	11.7±1.0	28.7±1.3	40.6±2.4	18.9±1.9	-	67.3±4.1
Good condition	39.7±3.1	26.4±3.0	16.7±2.1	17.2±2.7	-	41.6±5.9
Desert Grassland						
Poor condition	5.0±1.3	52.6±3.1	32.5±1.6	9.6±1.2	-	11.6±2.9
Good condition	67.4±1.7	27.8±2.7	4.3±0.9	1.1±1.6	-	38.8±3.6
Desertscrub						
Poor condition	-	47.8±3.1	6.4±4.6	39.8±1.7	5.5±2.6	11.3±3.4
Good condition	20.6±1.3	34.6±2.9	9.4±4.1	31.2±3.0	4.3±1.9	18.1±2.4
Mixed Shrub - Dry Wash						
Poor condition	2.4±1.1	7.9±3.5	11.6±1.7	20.4±0.6	58.2±1.1	16.5±2.2
Good condition	21.1±0.9	5.2±1.6	32.6±1.2	25.3±1.4	15.9±2.6	49.4±3.6
Mixed Broadleaf Riparian						
Poor condition	1.0±0.7	3.7±1.6	12.9±3.1	61.8±3.7	19.7±2.1	13.4±1.1
Good condition	21.6±1.7	21.3±2.0	11.8±0.8	36.7±2.9	8.7±0.6	31.6±2.1

Class 1	1'
Class 2	1 - 2'
Class 3	2 - 4'
Class 4	4 - 15'
Class 5	15'

livestock use of short shrubs typical for this habitat site (brittlebush Encellia farnosa and burrsage Ambrosia deltodeia).

Condition classes (poor and good) demonstrated differences in percentages of rock and downed litter cover (Table 4). Poor condition study areas of all five standard habitat sites showed slightly larger percentages of rock cover than at good condition sites with the largest difference represented by desert grassland (Table 4). The greatest difference in percent litter cover between condition classes occurred at desert grassland, mixed shrub-dry wash, and deciduous woodland riparian standard habitat sites (Table 4). Desertscrub demonstrated the smallest differences in percent litter cover between the two condition classes (Table 4). The chaparral standard habitat site was the only community with higher percentages of downed litter at good condition sites (Table 4).

Lizard detectibility for transects run through good condition standard habitat sites were generally lower than at poor condition sites (with the exception of chaparral). Lower densities are a result of greater amounts of low height vegetation (less than two feet) and cover at good condition sites that reduce visibility. Densities of lizards at these sites are underestimated and therefore, differences between good and poor condition sites are greater than indicated. Larger amounts of low height vegetation and cover made juveniles less detectible and adult to juvenile ratios thus greater at good condition sites.

Table 4. Summary of percent rock and litter cover ± one standard deviation for five standard habitat sites. N= 14 for each condition class.

Standard Habitat Site	Rock Cover (10cm)	Litter Cover	Total Cover
Chaparral			
Poor condition	8.7±4.1	2.3±3.7	11.0±3.9
Good condition	6.8±3.9	3.9±3.3	10.7±3.5
Desert Grassland			
Poor condition	29.6±4.3	11.6±3.6	41.2±4.0
Good condition	23.4±2.9	0.9±2.1	24.3±2.5
Desertscrub			
Poor condition	68.6±6.7	6.5±1.7	75.1±3.8
Good condition	57.3±8.3	4.9±2.3	62.2±5.0
Mixed Shrub - Dry Wash			
Poor condition	14.3±6.1	33.5±4.9	47.8±5.3
Good condition	10.7±4.6	6.3±2.6	17.0±3.3
Mixed Broadleaf Riparian			
Poor condition	21.2±4.0	36.6±5.6	57.8±4.8
Good condition	17.9±5.1	9.4±3.2	27.3±4.3

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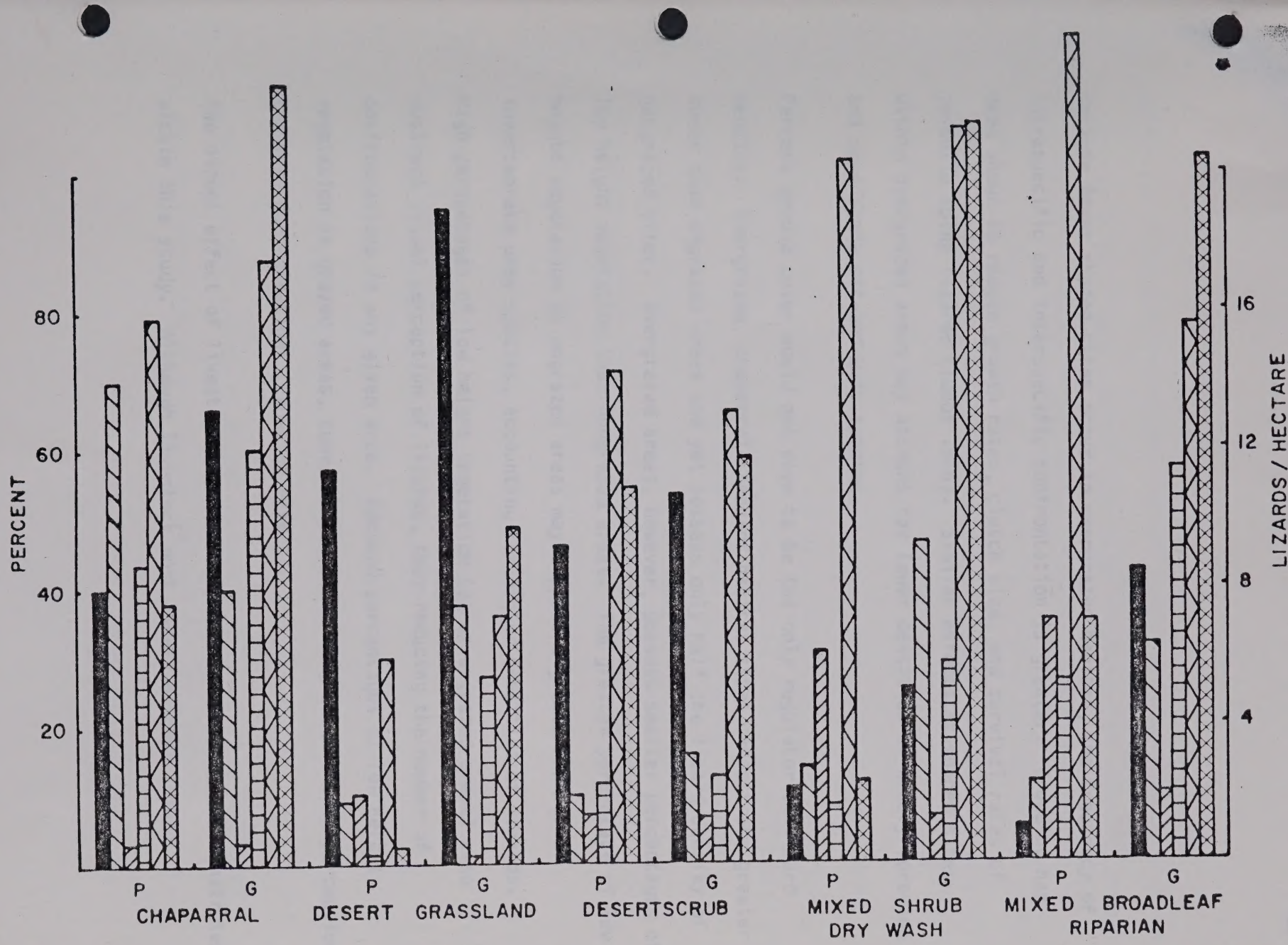
DISCUSSION

The effects of grazing on lizard species vary, depending on the relative percentages of low height vegetation, cover, and litter. Low percentages of vegetation less than 2 feet and cover in overgrazed areas resulted in lower densities of widely foraging and open space sit-and-wait lizard species (Figure 2). These species also demonstrated higher adult to juvenile and sex ratios in heavily grazed areas (poor condition habitat) (Table 2), which is an indication of unstable population trends.

Turner (1976) discussed high adult to juvenile and sex ratios as an indication of low population stability. His hypothesis is especially relevant for comparing identical species in different areas (relative comparison) during similar times of the year (as was done in the present study).

Lower densities of widely foraging and open space sit-and-wait lizard species in overgrazed areas would seem to result from reduced amounts of prey species and crowding effects in shaded areas. Reduced amounts of prey species result from a reduction in low vegetation and cover, which has been shown to account for lower populations of whiptail lizards (Vitt and Ohmart 1977).


PERCENT
80
60
40
20
LIZARDS / HECTARE
16
12
8
4
P
G
CHAPARRAL
DESERT GRASSLAND
DESERTSCRUB
MIXED SHRUB DRY WASH
MIXED BROADLEAF RIPARIAN
VEGETATION 2' AND SHORTER (CLASS 1 & 2)
VEGETATIVE COVER
P = POOR CONDITION
G = GOOD GONDITION
LITTER COVER
WIDELY FORAGING SPECIES
SIT-AND-WAIT SPECIES (UNDER AND ON LITTER, ROCKS, AND TREES)
SIT-AND-WAIT SPECIES (OPEN SPACES BETWEEN SHRUBS)

Because fewer shaded sites occur in overgrazed habitat, the frequency of intraspecific and interspecific confrontation is greater. Crowding has been shown to reduce growth rates, clutch size, and survival rates of juvenile spiny lizards (Tubbs 1976). Similar effects at shaded sites within overgrazed areas may account for lower densities of widely foraging and open space sit-and-wait species.

Percent ground cover would not seem to be the only regulator of lizard density. Overgrazed, chaparral standard habitat sites demonstrate greater cover than ungrazed areas and yet possess only half the lizard density of nongrazed sites. Overgrazed areas, however, possess smaller percentages of low height vegetation than nongrazed areas. The greater percentage of low height vegetation at ungrazed areas may support a greater number of invertebrate prey species, accounting for higher densities of lizards. High percentages of low height vegetation (as at ungrazed areas) also obstruct visual perception of lizards, thus reducing the number of confrontations in any given area. Reduced percentages of low height vegetation in grazed areas, conversely, result in greater visual perception and more confrontations (crowding effect).

The direct effect of livestock on lizard populations cannot be demonstrated within this study. Although livestock most likely disturb lizard

behavioral (reproductive and territorial) patterns, this disturbance is not discussed in this paper. Rather this paper discusses the secondary effects of livestock on lizards. Overgrazing primarily affects the existing vegetation by reducing low height vegetation percentages and percent cover. The loss of low height vegetation and cover therefore reduces the densities of widely foraging and open space sit-and-wait species.

In four out of five standard habitat sites studied, overgrazing reduced cover and vegetative composition. On desertscrub standard habitat sites, however, cover and low height composition did not differ between grazed and ungrazed areas, because these areas consist of mostly nonpalatable shrubs (burrsage and brittlebush). Since cover and low height vegetation percentage do not differ between grazed and ungrazed desertscrub sites, lizard densities are also similar.

Sit-and-wait foragers under bushes and in trees, rocks, and litter exhibit higher densities in overgrazed areas. This phenomenon seems to be related to increases in downed litter in overgrazed situations (especially in riparian areas where woody shrubs and trees prevail) caused by livestock knocking down low branches. Increased downed litter provides additional space and roosting sites for sit-and-wait lizards (of rock, litter, and trees). Larger amounts of downed partially decomposed litter also make available more habitat for various invertebrate prey species.

The herbivorous desert iguana and chuckwalla (Sauromalus obesus) were not observed with great enough frequency to determine a relationship between population densities and grazing. The desert iguana has been shown to forage high percentages of creosote bush (Larrea diverticata) buds (Norris 1953). High dietary percentages of creosote bush buds and low livestock utilization on this non-palatable plant species should result in small differences in desert iguana densities when comparing grazed and nongrazed areas. Chuckwallas on the other hand require a greater number of plant species (especially forbs and succulent annuals) in their diet (Berry 1974). Livestock overutilization therefore may reduce chuckwalla populations by decreasing these important dietary constituents available to the lizard. Nocturnal activity periods of the banded gecko and gila monster (Heloderma suspectum) made observations so infrequent that no conclusion could be drawn as to the effects of grazing on these lizard populations.

Management plans that allow for sites to develop to full vegetative potential will result in the highest lizard density and diversity possible. The total elimination of grazing from an area is not always the answer. Rest-rotation grazing systems can effectively increase vegetative production and initiate the restoration of the potential floral components. Certain areas may need more immediate management due to rapidly decreasing population conditions. Fencing and other means of excluding livestock may

be needed to obtain population stability.

Management priorities can be established by standard habitat site. This study indicates that desert grassland, mixed shrub-dry wash, and mixed broadleaf riparian sites should receive highest priority. Desertscrub, conversely, should receive lowest management priority because of minimal effects of grazing on this habitat type.

The BLM manages habitat and not individual species. By understanding how vegetative potential relates to the proper management of habitat types, the BLM can develop an effective means of obtaining lizard populations of highest diversity and stability.

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